

WHAT IS CLAIMED IS:

1. A fuel cell for use with a hydride-based fuel, wherein the fuel cell is constructed and arranged to be sealed in a liquid-tight manner when in operation and wherein the fuel cell comprises at least one opening for allowing hydrogen gas formed inside the fuel cell to escape therefrom, which opening is sealed by a membrane that is pervious to hydrogen gas and impervious to liquids and solids.
2. The fuel cell of claim 1, wherein the membrane comprises a porous membrane which comprises a hydrophobic material.
3. The fuel cell of claim 2, wherein the membrane comprises pores having diameters of from about 0.1 μm to about 5 μm .
4. The fuel cell of claim 3, wherein the membrane has a thickness of from about 100 μm to about 300 μm .
5. The fuel cell of claim 2, wherein the hydrophobic material comprises a fluorine containing polymer.
6. The fuel cell of claim 5, wherein the fluorine containing polymer comprises a fluorine containing polyolefin.
7. The fuel cell of claim 4, wherein the hydrophobic material comprises polytetrafluoroethylene.
8. The fuel cell of claim 5, wherein the membrane further comprises activated carbon.
9. The fuel cell of claim 8, wherein the activated carbon is at least one of dispersed in and bonded by the fluorine containing polymer.

10. The fuel cell of claim 6, wherein the porous membrane comprises a hydrogen-pervious coating on at least a side thereof which faces an interior of the fuel cell, which coating has a surface energy which is lower than the surface energy of the porous membrane.

11. The fuel cell of claim 10, wherein the coating comprises a polymer with repeating units which comprise a fluorinated aliphatic group having at least about 5 fluorine atoms.

12. The fuel cell of claim 11, wherein the fluorinated aliphatic group comprises a fluoroalkyl group having from about 4 to about 20 carbon atoms.

13. The fuel cell of claim 12, wherein the fluorinated aliphatic group comprises a perfluoroalkyl group having from about 6 to about 10 carbon atoms.

14. The fuel cell of claim 11, wherein the fluorinated aliphatic group comprises a perfluorooctyl group.

15. The fuel cell of claim 7, wherein the polymer comprises units derived from perfluorooctyl methacrylate.

16. The fuel cell of claim 1, wherein the membrane is a porous membrane which comprises an inorganic material.

17. The fuel cell of claim 16, wherein the inorganic material comprises at least one of glass, ceramic, metal, alumina and zeolite.

18. The fuel cell of claim 17, wherein the membrane comprises pores having diameters of from about 0.1 μm to about 5 μm .

19. The fuel cell of claim 18, wherein the membrane has a thickness of from about 20 μm to about 1 mm.

20. The fuel cell of claim 18, wherein the membrane comprises a borosilicate material.
21. The fuel cell of claim 17, wherein the membrane comprises stainless steel.
22. The fuel cell of claim 16, wherein the membrane comprises a gas-pervious hydrophobic coating on at least a side thereof which faces an interior of the fuel cell.
23. The fuel cell of claim 22, wherein the coating comprises fluorinated aliphatic groups having at least about 5 fluorine atoms.
24. The fuel cell of claim 23, wherein the fluorinated aliphatic groups comprise fluoroalkyl groups having from about 4 to about 20 carbon atoms.
25. The fuel cell of claim 24, wherein the fluorinated aliphatic groups comprise perfluoroalkyl groups having from about 6 to about 10 carbon atoms.
26. The fuel cell of claim 23, wherein the fluorinated aliphatic groups comprise a perfluorooctyl group.
27. The fuel cell of claim 22, wherein the coating is derived from one or more hydrolyzable silanes which have at least one fluorinated aliphatic group directly bonded to a silicon atom, the fluorinated aliphatic group comprising from about 6 to about 10 carbon atoms and at least about 5 fluorine atoms.
28. The fuel cell of claim 27, wherein the one or more hydrolyzable silanes comprise at least one trialkoxyperfluoroalkylsilane.

29. The fuel cell of claim 28, wherein the at least one trialkoxyperfluoroalkylsilane comprises at least one of trimethoxyperfluorooctylsilane and triethoxyperfluorooctylsilane.

30. The fuel cell of claim 1, wherein the membrane is a non-porous membrane.

31. The fuel cell of claim 30, wherein the membrane comprises at least one of a silicone rubber and PTFE-treated activated carbon.

32. The fuel cell of claim 31, wherein the membrane comprises from about 90 % to about 50 % by weight of activated carbon and from about 50 % to about 10 % by weight of PTFE.

33. The fuel cell of claim 32, wherein the membrane has a thickness of from about 20 μm to about 1000 μm .

34. A membrane unit for a fuel cell which uses a hydride-based fuel, wherein the unit is impervious to liquid and solid components of a hydride-based fuel and comprises at least one membrane which is pervious to gas.

35. The membrane unit of claim 34, wherein the unit comprises at least one membrane which is impervious to liquid and pervious to hydrogen and, on at least one side of the at least one membrane, a protective element which protects the at least one membrane from at least one of a physical and a chemical attack by the fuel and its decomposition and reaction products.

36. The membrane unit of claim 35, wherein the protective element comprises a porous gas-pervious membrane which is more resistant to at least one of a physical and a chemical attack by the fuel and its decomposition and reaction products than the at least one membrane.

37. The membrane unit of claim 36, wherein the protective element comprises a porous membrane which comprises activated carbon.

38. The membrane unit of claim 37, wherein the porous membrane further comprises a fluorine containing polymer.

39. The membrane unit of claim 38, wherein the activated carbon is at least one of dispersed in and bonded by the fluorine containing polymer.

40. The membrane unit of claim 39, wherein the fluorine containing polymer comprises polytetrafluoroethylene.

41. The membrane unit of claim 35 wherein the protective element comprises a structure with sufficiently small openings to substantially prevent a physical attack of the at least one membrane by fuel-derived liquid and solid particles of high kinetic energy.

42. The membrane unit of claim 41 wherein the openings comprise holes having a diameter of not more than about 5 mm.

43. The membrane unit of claim 35, wherein the protective element comprises a structure with skewed slots.

44. The membrane unit of claim 32, wherein the protective element comprises a foam element which comprises pores having diameters which are large enough to allow liquid to pass through the foam element.

45. The membrane unit of claim 44, wherein the foam element comprises pores having diameters of from about 0.3 mm to about 5 mm.

46. The membrane unit of claim 44, wherein the foam element has a thickness of from about 1 mm to about 5 mm.

47. The membrane unit of claim 46, wherein the foam element comprises polytetrafluoroethylene.

48. The membrane unit of claim 35, wherein the protective element comprises at least one of polyurethane, polyethylene, polypropylene, polyvinyl chloride and ABS copolymer.

49. The membrane unit of claim 34, wherein the at least one membrane comprises a reinforced membrane.

50. The membrane unit of claim 49, wherein the reinforced membrane is reinforced by a mesh.

51. The membrane unit of claim 50, wherein the mesh comprises at least one of a metallic material and an organic polymer.

52. The membrane unit of claim 51, wherein the mesh comprises at least one of nickel and stainless steel.

53. The membrane unit of claim 51, wherein the mesh comprises at least one of polytetrafluoroethylene, polypropylene, polyethylene and ABS copolymer.

54. The membrane unit of claim 34, wherein the at least one membrane comprises a porous membrane.

55. The membrane unit of claim 54, wherein the porous membrane comprises a hydrophobic material.

56. The membrane unit of claim 55, wherein the hydrophobic material comprises a fluorine containing polyolefin.

57. The membrane unit of claim 56, wherein the hydrophobic material comprises polytetrafluoroethylene.

58. The membrane unit of claim 55, wherein the porous membrane comprises a gas-pervious coating on at least one side thereof, which coating has a surface energy which is lower than the surface energy of the porous membrane.

59. The membrane unit of claim 58, wherein the coating comprises a polymer with repeating units which have a perfluoroalkyl group with from about 6 to about 10 carbon atoms.

60. The membrane unit of claim 59, wherein the coating comprises poly(perfluorooctyl methacrylate).

61. The membrane unit of claim 54, wherein the porous membrane comprises an inorganic material.

62. The membrane unit of claim 61, wherein the inorganic material comprises at least one of glass, ceramic, metal, alumina and zeolite.

63. The membrane unit of claim 61, wherein the porous membrane comprises a gas-pervious hydrophobic coating on at least one side thereof.

64. The membrane unit of claim 63, wherein the coating comprises fluorinated aliphatic groups having from about 6 to about 10 carbon atoms.

65. The membrane unit of claim 64, wherein the fluorinated aliphatic groups comprise a perfluorooctyl group.

66. The membrane unit of claim 64, wherein the coating is derived from one or more hydrolyzable silanes which comprise at least one of trimethoxyperfluorooctylsilane and triethoxyperfluorooctylsilane.

67. The membrane unit of claim 34, wherein the at least one membrane comprises a non-porous membrane.

68. The membrane unit of claim 67, wherein the membrane comprises at least one of a silicone rubber and PTFE-treated activated carbon.

69. A fuel cell for use with a hydride-based fuel, wherein the fuel cell comprises the membrane unit of claim 34.

70. A fuel cell for use with a hydride-based fuel, wherein the fuel cell comprises at least one material which is capable of at least one of absorbing, adsorbing and undergoing a chemical reaction with molecular hydrogen.

71. The fuel cell of claim 70, wherein the material comprises a hydrogen sponge.

72. The fuel cell of claim 71, wherein the hydrogen sponge comprises at least one of metallic platinum, palladium, titanium, nickel, aluminum and alloys thereof.

73. The fuel cell of claim 70, wherein the material comprises a molecular sieve.

74. The fuel cell of claim 70, wherein the material comprises at least one of ceramics, zeolites, organic polymers and activated carbon.

75. The fuel cell of claim 70, wherein the material comprises a compound which is capable of being hydrogenated.

76. The fuel cell of claim 70, wherein the material comprises a compound having at least one unsaturated bond.

77. The fuel cell of claim 76, wherein the at least one unsaturated bond comprises at least one of a carbon-carbon double and a carbon-carbon triple bond.

78. The fuel cell of claim 76, wherein the material comprises at least one olefin having at least about 5 carbon atoms.

79. The fuel cell of claim 78, wherein the at least one olefin comprises a hexene.

80. The fuel cell of claim 75, wherein the material further comprises a hydrogenation catalyst.

81. The fuel cell of claim 70, wherein the material comprises a compound which is capable of oxidizing hydrogen.

82. The fuel cell of claim 81, wherein the compound comprises an oxygen-containing compound.

83. The fuel cell of claim 82, wherein the oxygen-containing compound comprises a salt.

84. The fuel cell of claim 83, wherein the salt comprises at least one of nitrogen and sulfur.

85. The fuel cell of claim 84, wherein the salt comprises a nitrate.

86. The fuel cell of claim 81, wherein the material further comprises an oxidation catalyst.

87. The fuel cell of claim 70, wherein the material is enclosed by an inert material which is liquid-impervious and pervious to hydrogen.

88. The fuel cell of claim 87, wherein the inert material comprises a porous material.

89. The fuel cell of claim 87, wherein the inert material forms a part of an element which is capable of being removed from the fuel cell.

90. The fuel cell of claim 70, wherein the material is at least partially immobilized on one or more inner walls of the fuel cell.

91. A fuel cell for use with a hydride-based fuel, wherein the fuel cell comprises at least one material which is capable of at least one of absorbing, adsorbing and undergoing a chemical reaction with gaseous hydrogen formed therein, and wherein the fuel cell further comprises at least one opening for allowing hydrogen gas formed inside the fuel cell to escape therefrom, which opening is sealed by a membrane that is pervious to hydrogen and impervious to liquids and solids.

92. A fuel cell for use with a hydride-based fuel, wherein the fuel cell comprises at least one membrane unit according to claim 34.

93. A fuel cell for use with a hydride-based fuel, wherein the fuel cell comprises fuel cell walls and wherein at least a part of the fuel cell walls comprises a material which is pervious to hydrogen and impervious to liquids and solids.

94. A fuel cell for use with a hydride-based fuel, wherein the fuel cell has corners and at least two of these corners each comprise one or more openings which are sealed by a material which is pervious to hydrogen and impervious to liquids and solids.

95. The fuel cell of claim 94, wherein all of the corners of the fuel cell comprise one or more openings which are sealed by a material which is pervious to hydrogen and impervious to liquids and solids.

96. A fuel cell for use with a liquid fuel, wherein the fuel cell comprises a fuel chamber and an electrolyte chamber and at least one of the fuel chamber and the electrolyte chamber enclose a volume which is shaped approximately like a "C" or an "I" with two approximately horizontal portions and one approximately vertical portion.

97. The fuel cell of claim 96, wherein the two approximately horizontal portions together enclose a volume which is not larger than about 10 % of a total volume of the "C" or "I".

98. The fuel cell of claim 96, wherein the two approximately horizontal portions together enclose a volume which is not smaller than about 1 % of a total volume of the "C" or "I".

99. The fuel cell of claim 96, wherein the fuel chamber encloses a volume which is shaped approximately like a "C" or an "I".

100. The fuel cell of claim 96, wherein the electrolyte chamber encloses a volume which is shaped approximately like a "C" or an "I".

101. The fuel cell of claim 96, wherein both the fuel chamber and the electrolyte chamber enclose a volume which is shaped approximately like a "C" or an "I".

102. The fuel cell of claim 101, wherein each of the horizontal portions of the "C" and the "I" comprises at least one opening for allowing gas inside the fuel cell to escape therefrom, which opening is sealed by a membrane that is pervious to gas and impervious to liquids and solids.